CLAIMS

What is claimed is:

1. A method comprising:

covalently bonding a thermal interface material to a bottom surface of a heat dissipating device and/or a backside surface of a heat generating device; and

thermally coupling the heat dissipating device to the heat generating device, the thermal interface material disposed between the bottom surface of the heat dissipating device and the backside surface of the heat generating device.

2. The method of claim 1, wherein covalently bonding the thermal interface material to a bottom surface of a heat dissipating device and/or a backside surface of a heat generating device comprises electropolymerization of a monomer.

3. The method of claim 1, wherein covalently bonding the thermal interface material to a bottom surface of a heat dissipating device and/or a backside surface of a heat generating device comprises electrodeposition of an electroactive polymer.

4. The method of claim 3, wherein electrodeposition of an electroactive polymer comprises electrodeposition of an electroactive polymer on a metal surface of the heat dissipating device.

5. The method of claim 3, wherein the electroactive polymer has an electroactive end group $-NH_n^+$.

6. The method of claim 3, wherein the electroactive polymer has an electroactive end group -COOH or -COO-.

7. The method of claim 1, wherein covalently bonding the thermal interface material to a bottom surface of a heat dissipating device and/or a backside surface of a

heat generating device comprises surface grafting a polymer on the bottom surface of a heat dissipating device and/or a backside surface of a heat generating device.

8. The method of claim 1, wherein covalently bonding the thermal interface material to a bottom surface of a heat dissipating device and/or a backside surface of a heat generating device comprises chemically treating the backside surface of the heat generating device to generate a functional group that can react with the thermal interface material to form covalent bonds.

9. The method of claim 8, wherein chemically treating the backside surface of the heat generating device comprises oxidizing a silicon surface of the heat generating device with an oxidizing agent.

10. The method of claim 9, wherein the oxidizing agent is $KMnO_4$, and the thermal interface material comprises an epoxy resin.

11. The method of claim 1, wherein the heat generating device is an integrated circuit and the heat dissipating device is an integrated heat spreader.

12. The method of claim 11, wherein the thermal interface material has a bulk thermal conductivity greater than 4 W/mK.

13. A method comprising:

applying a thermal interface material to a backside surface of a heat generating device and/or a bottom surface of a heat dissipating device, wherein the thermal interface material comprises a polymer material with thermally conductive filler components dispersed therein, the thermally conductive filler components covalently bonded together and/or covalently bonded with the polymer material; and

attaching the heat dissipating device to the heat generating device, the thermal interface material disposed between the backside surface of the heat generating device and the bottom surface of the heat dissipating device.

14. The method of claim 13, wherein the TIM comprises a molecular composite material with covalent bonding between metal or ceramic filler components.

15. The method of claim 13, comprising producing the thermal interface material by chemically treating metal or ceramic filler components to form a functional group that can react with the polymer material to form covalent bonds.

16. An apparatus, comprising:

a heat generating device;

a heat dissipating device thermally coupled to a backside surface of the heat generating device; and

a first thermal interface material disposed between the backside surface of the heat generating device and a bottom surface of the heat dissipating device, the first thermal interface material covalently bonded to the bottom surface of the heat dissipating device and/or the backside surface of the heat generating device.

17. The apparatus of claim 16, wherein the heat generating device is an integrated circuit.

18. The apparatus of claim 17, wherein the first thermal interface material comprises an epoxy resin covalently bonded to the backside surface of the integrated circuit.

19. The apparatus of claim 16, wherein the first thermal interface material comprises a molecular composite material.

20. The apparatus of claim 16, wherein the first thermal interface material comprises a nanocomposite material.

21. The apparatus of claim 16, wherein the first thermal interface material comprises a thermally conductive polymer.

22. The apparatus of claim 16, wherein the first thermal interface material has a thermal conductivity greater than 4 W/mK.

23. The apparatus of claim 16, comprising an electroactive polymer bonded to the heat dissipating device by electrodeposition.

24. The apparatus of claim 16, wherein the heat dissipating device is an integrated heat spreader.

25. The apparatus of claim 24, comprising a heat sink thermally coupled to a top surface of the integrated heat spreader.

26. The apparatus of claim 25, comprising a second thermal interface material disposed between the top surface of the integrated heat spreader and a bottom surface of the heat sink, the second thermal interface material covalently bonded to the bottom surface of the heat sink and/or the top surface of the integrated heat spreader.